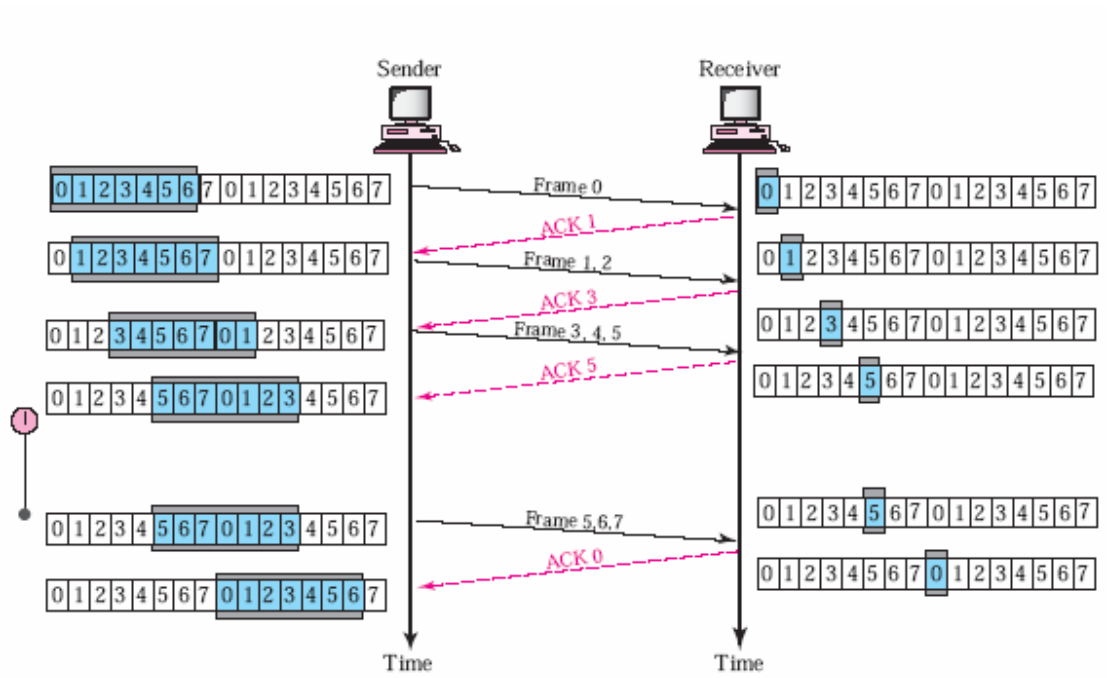
Error Control and Flow Control

1. In Stop-and-Wait ARQ why should the receiver always send an acknowledgment message each time it receives a frame with the wrong sequence number?

   First, lets look at how this situation can occur. The sender sends a frame and the receiver successfully receives it and sends an ACK but the ACK gets lost. The sender will time out and re-send the frame. The sender cannot send the next frame until it has received the ACK for the current frame. When the receiver receives this re-transmission, it will be expecting the next frame and the resend will appear to have the wrong sequence number. If the receiver does not send an ACK for this frame, the sender will never step on to the next frame. This means the receiver should always send an ACK for all transmissions received if the overall transfer is to be completed successfully.

2. Draw the sender and receiver windows (size 7) and show the operation for a system using Go-Back-N ARQ, given the following:
   a. Frame 0 is sent; Frame 0 is acknowledged.
   b. Frames 1 and 2 are sent; Frames 1 and 2 are acknowledged.
   c. Frames 3,4, and 5 are sent; Frame 4 is acknowledged; timer for frame 5 expires.
   d. Frames 5,6, and 7 are sent; Frames 4 through 7 are acknowledged.



3. Bob from RMIT sends a few MP3 files electronically to John at Monash University using Go-Back-N ARQ. The transmission link between RMIT and Monash is mostly noisy. Bob finds Go-Back-N ARQ to be very inefficient for a noisy link and decides to switch to Selective Repeat ARQ. Did Bob make the right decision? If so, explain why Go-Back-N ARQ is very inefficient in a noisy link, but Selective Repeat ARQ is found to be more efficient for the same link.

Yes, Bob made the right decision. A frame has a higher probability of damage or loss in a noisy link. When a frame is lost (or damaged) while using Go-Back-N ARQ, not only the frame in error needs to be retransmitted, but one or more subsequent frames. This retransmission consumes more bandwidth and slows down the transmission. With Selective Repeat ARQ, only the damaged frame is retransmitted by the sender. Therefore, Bob finds Selective Repeat ARQ to be more efficient for the noisy link.

4. Consider the use of 1000-bit frames on a 1-Mbps satellite channel with a 270-ms delay. What is the maximum link utilization for
   a. Stop-and-Wait flow control
   b. Continuous flow control with a window size of 7?
   c. Continuous flow control with a window size of 127?
   d. Continuous flow control with a window size of 255?

   For stop-and-wait: U= 1/(1+2a) and for Continuous flow control:
   U= W/(1+2a)

   Here, a= (Propagation Time)/ (Transmission Time)
   Now, Transmission Time = (Frame Length) / (Data Rate)

   The following values are given:

   Propagation Time = 270 ms = 270 x 10^{-3} sec
   Frame Length = 1000 bits
   Data Rate = 1 Mbps= 1 x 10^{6} bps

   Therefore, a = (270 x $10^{-3)}$ / (1000 /1 x $10^{6)}$ = 270

   a. U= 1/(1+2a) = 1/(1+2 x 270) = 1/541 = 0.002
   b. U= W/(1+2a) = 7/(1+2 x 270) = 7/541 = 0.013
   c. U= W/(1+2a) = 127/(1+2 x 270) = 127/541 = 0.23
   d. U= W/(1+2a) = 255/(1+2 x 270) = 255/541 = 0.47

Note: Students can use alternative approach such as BW-delay product.